We claim:

1. A ceramic/metal composite material comprising a boride- or carbide-based ceramic portion and an alumina-aluminum binding phase, wherein the composite material has been substantially fully reacted with aluminum.

2. The composite material of claim 1, wherein the material is substantially non-reactive with aluminum.

3. The composite material of claim 1, wherein the ceramic portion comprises silicon carbide, boron carbide, or titanium diboride, or mixtures thereof.

4. The composite material of claim 3, wherein the ceramic portion comprises particulate silicon carbide having an average diameter of between about 5 micrometers and about 5000 micrometers.

5. The composite material of claim 1, comprising at least 50 volume percent carbide particles.

6. The composite material of claim 5, comprising at least 60 volume percent carbide particles.

7. The composite material of claim 1, comprising between about 50 and 90 volume percent carbide, between about 32 and 7 volume percent aluminum oxide, and between about 18 and 3 volume percent aluminum.

8. The composite material of claim 1, comprising an essentially continuous ceramic portion.

9. The composite material of claim 1, wherein the alumina-aluminum binding phase is formed by reacting silica in a silica-bonded boride- or carbide-based ceramic preform with an aluminum alloy having between about 18 weight percent and about 95 weight percent silicon.

10. The composite material of claim 9, comprising less than about five weight percent silica.

11. The composite material of claim 10, comprising less than about one weight percent silica.

12. A composite material comprising a boride- or carbide-based ceramic portion and an alumina-aluminum binding phase, wherein the material is substantially non-reactive with aluminum and aluminum alloy.

13. An article comprising a ceramic/metal composite having a matrix formed from a silica-bonded boride- or carbide-based ceramic portion and an aluminum alloy portion, wherein the silica has been substantially fully reacted with aluminum to form alumina.

14. The article of claim 13, wherein the article is capable of contact with molten aluminum without significant reaction with the aluminum.

15. The article of claim 14, wherein the article is selected from the group consisting of riser tubes, dies/molds, heater immersion tubes, thermocouple protection tubes, ladles, and stirring devices.

16. The article of claim 13, wherein the article has one or more surfaces to be exposed to friction or wear.

17. The article of claim 16, wherein the article is selected from the group consisting of bearings, nozzles, bushings, valve components, liners, brake components, clutches, engine components, and turbine components.

18. The article of claim 13, wherein the article is an electrical conductor.

19. The article of claim 18, wherein the article is selected from the group consisting of electric motor brushes, high temperature/hostile environment sensors, high temperature/hostile environment probes, electrodes, and current collectors.

20. The article of claim 13, wherein the article is a thermal management device.

21. The article of claim 20, wherein the article is selected from the group consisting of heat spreaders, heat sinks, thermal diffusers, and substrates.

22. The article of claim 13, wherein the article absorbs and dissipates kinetic energy from high velocity projectiles.

23. The article of claim 13, wherein the ceramic portion comprises silicon carbide, boron carbide, or titanium diboride, or mixtures thereof.

24. A method for forming a boride- or carbide-based ceramic/metal composite, comprising

    a. contacting a silica-bonded boride- or carbide-based preform with a molten metal comprising between about 18 weight percent and about 95 weight percent silicon, the remainder being substantially aluminum and impurities;

    b. allowing reaction between the aluminum and the silica in the preform to go substantially to completion to form a composite having at least about 50 volume percent boride or carbide, the remainder comprising alumina, aluminum, and impurities; and

    c. removing the composite from contact with the molten metal.

25. The method of claim 24, further comprising forming the silica-bonded boride- or carbide-based preform having at least about 50 volume percent boride or carbide prior to contacting the preform with a molten metal.

26. The method of claim 25, further comprising forming the preform in substantially the same shape and size as a desired product article.

27. The method of claim 24, wherein contacting the preform with a molten metal comprises submerging the preform in the molten metal.

28. The method of claim 24, wherein the molten metal comprises between about 20 weight percent and about 30 weight percent silicon.

29. The method of claim 28, wherein the molten metal comprises about 25 weight percent silicon.

30. The method of claim 24, wherein the molten metal is at a temperature of between about 1000°C and about 1250°C.

31. The method of claim 30, wherein the molten metal is at a temperature of about 1150°C.

32. The method of claim 24, wherein the preform comprises at least about 60 volume percent boride or carbide.

33. The method of claim 32, wherein the preform comprises at least about 90 volume percent boride or carbide.

34. The method of claim 24, wherein the preform comprises silicon carbide, boron carbide, or titanium diboride, or mixtures thereof.

35. The method of claim 34, wherein the preform comprises silicon carbide.

36. The method of claim 24, wherein the preform comprises boride or carbide particles generally having a particle diameter of between about 5 micrometers and about 5000 micrometers.

37. The method of claim 24, further comprising maintaining substantially the same shape and size of the preform as the reaction progresses.

38. A composite material made in accordance with the method of claim 24.

39. An article comprising a composite material made in accordance with the method of claim 24.

40. The article of claim 39, wherein the article is in substantially the same shape and size as the preform.

41. The article of claim 39, wherein the article is selected from the group consisting of riser tubes, molds, heater immersion tubes, thermocouple protection tubes, bearings, nozzles, bushings, valve components, liners, electric motor brushes, high temperature/hostile environment sensors, high temperature/hostile environment probes, electrodes, current collectors, and armor.

42. A method for forming a ceramic/metal composite, comprising

    a. contacting a ceramic preform having a reactive bonding agent with a molten metal bath to initiate the reaction between the reactive bonding agent and prevent the reaction:

$$A_wB_x + M \rightarrow M_yB_z + N\ ;$$

wherein A_wB_x is a ceramic (B not necessarily boron);

M is a metal in the molten metal bath selected from the group consisting of Al, Fe, Ni, Co, Mg, Ti, Ta, W, Y, Nb, and mixtures and alloys thereof that is reactive with the bonding agent;

M_yB_z is an undesired reaction product; and

N, which may or may not be A and is not nitrogen, is a metal included in the molten metal bath; and

whereas a sufficient amount of N is present in the molten metal bath to stabilize A_wB_x;

b. allowing the reaction between the metal M and the bonding agent in the preform to go substantially to completion to form a composite having at least about 50 volume percent ceramic, the remainder comprising metal M, a reaction product of metal M and bonding agent, and impurities; and

c. removing the composite from contact with the molten metal.